

## PATENT COOPERATION TREATY

PCT

NOTIFICATION OF THE RECORDING  
OF A CHANGE(PCT Rule 92bis.1 and  
Administrative Instructions, Section 422)

From the INTERNATIONAL BUREAU

To:

OUTOKUMPU OYJ  
Intellectual Property Management  
P.O. Box 27  
FIN-02201 Espoo  
FINLANDE

Date of mailing (day/month/year) 11 December 2000 (11.12.00)	IMPORTANT NOTIFICATION
Applicant's or agent's file reference 982060 WO	
International application No. PCT/FI99/00782	International filing date (day/month/year) 23 September 1999 (23.09.99)

1. The following indications appeared on record concerning:		
<input type="checkbox"/> the applicant	<input type="checkbox"/> the inventor	<input checked="" type="checkbox"/> the agent
<input type="checkbox"/> the common representative		
Name and Address OUTOKUMPU OYJ Patent Services P.O. Box 27 FIN-02201 Espoo Finland	State of Nationality	State of Residence
	Telephone No. 398-9-4211	
	Facsimile No. 398-9-4212978	
	Teleprinter No.	
2. The International Bureau hereby notifies the applicant that the following change has been recorded concerning:		
<input type="checkbox"/> the person	<input type="checkbox"/> the name	<input checked="" type="checkbox"/> the address
<input type="checkbox"/> the nationality		
<input type="checkbox"/> the residence		
Name and Address OUTOKUMPU OYJ Intellectual Property Management P.O. Box 27 FIN-02201 Espoo Finland	State of Nationality	State of Residence
	Telephone No. 398-9-4211	
	Facsimile No. 398-9-4212978	
	Teleprinter No.	
3. Further observations, if necessary:		
4. A copy of this notification has been sent to:		
<input checked="" type="checkbox"/> the receiving Office	<input type="checkbox"/> the designated Offices concerned	
<input type="checkbox"/> the International Searching Authority	<input checked="" type="checkbox"/> the elected Offices concerned	
<input checked="" type="checkbox"/> the International Preliminary Examining Authority	<input type="checkbox"/> other:	

The International Bureau of WIPO 34, chemin des Colombettes 1211 Geneva 20, Switzerland	Authorized officer A. Karkachi
Facsimile No.: (41-22) 740.14.35	Telephone No.: (41-22) 338.83.38

# PATENT COOPERATION TREATY

**PCT**

## NOTICE INFORMING THE APPLICANT OF THE COMMUNICATION OF THE INTERNATIONAL APPLICATION TO THE DESIGNATED OFFICES

(PCT Rule 47.1(c), first sentence)

From the INTERNATIONAL BUREAU

To:

OUTOKUMPU OYJ  
Patent Services  
P.O. Box 27  
FIN-02201 Espoo  
FINLAND

Received

10.04.00

Date of mailing (day/month/year) 30 March 2000 (30.03.00)		
Applicant's or agent's file reference 982080 WO		
<b>IMPORTANT NOTICE</b>		
International application No. PCT/FI99/00782	International filing date (day/month/year) 23 September 1999 (23.09.99)	Priority date (day/month/year) 24 September 1998 (24.09.98)
Applicant OUTOKUMPU OYJ et al		

1. Notice is hereby given that the International Bureau has communicated, as provided in Article 20, the international application to the following designated Offices on the date indicated above as the date of mailing of this Notice:
- AU,CN,JP,KR,US**

In accordance with Rule 47.1(c), third sentence, those Offices will accept the present Notice as conclusive evidence that the communication of the international application has duly taken place on the date of mailing indicated above and no copy of the international application is required to be furnished by the applicant to the designated Office(s).

2. The following designated Offices have waived the requirement for such a communication at this time:
- BG,BR,CA,EA,EP,IN,MX,PL,ZA**

The communication will be made to those Offices only upon their request. Furthermore, those Offices do not require the applicant to furnish a copy of the international application (Rule 49.1(a-bis)).

3. Enclosed with this Notice is a copy of the international application as published by the International Bureau on 30 March 2000 (30.03.00) under No. WO 00/17419

### REMINDER REGARDING CHAPTER II (Article 31(2)(a) and Rule 54.2)

If the applicant wishes to postpone entry into the national phase until 30 months (or later in some Offices) from the priority date, a demand for international preliminary examination must be filed with the competent International Preliminary Examining Authority before the expiration of 19 months from the priority date.

It is the applicant's sole responsibility to monitor the 19-month time limit.

Note that only an applicant who is a national or resident of a PCT Contracting State which is bound by Chapter II has the right to file a demand for international preliminary examination.

### REMINDER REGARDING ENTRY INTO THE NATIONAL PHASE (Article 22 or 39(1))

If the applicant wishes to proceed with the international application in the national phase, he must, within 20 months or 30 months, or later in some Offices, perform the acts referred to therein before each designated or elected Office.

For further important information on the time limits and acts to be performed for entering the national phase, see the Annex to Form PCT/IB/301 (Notification of Receipt of Record Copy) and Volume II of the PCT Applicant's Guide.

<p>The International Bureau of WIPO 34, chemin des Colombettes 1211 Geneva 20, Switzerland</p> <p>Facsimile No. (41-22) 740.14.35</p>	<p>Authorized officer J. Zahra</p> <p>Telephone No. (41-22) 338.83.38</p>
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REC'D 29 DEC 2000

WIPO

PCT

## INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Article 36 and Rule 70)

8

Applicant's or agent's file reference 982060 WO	<b>FOR FURTHER ACTION</b> See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416)	
International application No. PCT/FI99/00782	International filing date (day/month/year) 23.09.1999	Priority date (day/month/year) 24.09.1998
International Patent Classification (IPC) or national classification and IPC7 C25C 7/02		
Applicant Outokumpu Oyj et al		

1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.
2. This REPORT consists of a total of 4 sheets, including this cover sheet.
- ☐ This report is also accompanied by ANNEXES, i.e., sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).

These annexes consist of a total of \_\_\_\_\_ sheets.

3. This report contains indications relating to the following items:

- I ☒ Basis of the report
- II ☐ Priority
- III ☐ Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
- IV ☐ Lack of unity of invention
- V ☒ Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
- VI ☐ Certain documents cited
- VII ☐ Certain defects in the international application
- VIII ☐ Certain observations on the international application

Date of submission of the demand  14.04.2000	Date of completion of this report  19.12.2000
Name and mailing address of the IPEA/SE Patent- och registreringsverket Box 5055 S-102 42 STOCKHOLM Facsimile No. 08-667 72 88	Authorized officer  Ulrika Nilsson/MP Telephone No. 08-782 25 00

# INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No.  
PCT/FI99/00782

## I. Basis of the report

### 1. With regard to the **elements** of the international application:\*

- ☒ the international application as originally filed
- ☐ the description:  
pages \_\_\_\_\_, as originally filed  
pages \_\_\_\_\_, filed with the demand  
pages \_\_\_\_\_, filed with the letter of \_\_\_\_\_
- ☐ the claims:  
pages \_\_\_\_\_, as originally filed  
pages \_\_\_\_\_, as amended (together with any statement) under article 19  
pages \_\_\_\_\_, filed with the demand  
pages \_\_\_\_\_, filed with the letter of \_\_\_\_\_
- ☐ the drawings:  
pages \_\_\_\_\_, as originally filed  
pages \_\_\_\_\_, filed with the demand  
pages \_\_\_\_\_, filed with the letter of \_\_\_\_\_
- ☐ the sequence listing part of the description:  
pages \_\_\_\_\_, as originally filed  
pages \_\_\_\_\_, filed with the demand  
pages \_\_\_\_\_, filed with the letter of \_\_\_\_\_

### 2. With regard to the **language**, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item. These elements were available or furnished to this Authority in the following language \_\_\_\_\_ which is:

- ☐ the language of a translation furnished for the purposes of international search (under Rule 23.1(b)).
- ☐ the language of publication of the international application (under Rule 48.3(b)).
- ☐ the language of the translation furnished for the purposes of international preliminary examination (under Rules 55.2 and/or 55.3).

### 3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international preliminary examination was carried out on the basis of the sequence listing:

- ☐ contained in the international application in written form.
- ☐ filed together with the international application in computer readable form.
- ☐ furnished subsequently to this Authority in written form.
- ☐ furnished subsequently to this Authority in computer readable form.
- ☐ The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.
- ☐ The statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished.

### 4. ☐ The amendments have resulted in the cancellation of:

- ☐ the description, pages \_\_\_\_\_
- ☐ the claims, Nos. \_\_\_\_\_
- ☐ the drawings, sheet/fig \_\_\_\_\_

### 5. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed, as indicated in the Supplemental Box (Rule 70.2 (c)).\*\*

\* Replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are annexed to this report since they do not contain amendments (Rules 70.16 and 70.17).

\*\* Any replacement sheet containing such amendments must be referred to under item I and annexed to this report.

# INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No.  
PCT/FI99/00782

## V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

### 1. Statement

Novelty (N)	Claims	<u>1-17</u>	YES
	Claims		NO
Inventive step (IS)	Claims	<u>8-17</u>	YES
	Claims	<u>1-7</u>	NO
Industrial applicability (IA)	Claims	<u>1-17</u>	YES
	Claims		NO

### 2. Citations and explanations (Rule 70.7)

The claimed invention relates to a method for manufacturing a suspension bar, consisting of a rigid metal outer jacket enclosing a highly electroconductive inner part, for a permanent cathode used in the electrolysis of metals. The aim of the claimed invention is to enable a tight contact between the outer refined steel jacket and the highly electroconductive core. For this purpose, the outer jacket of refined steel and the core are joined together by drawing, upsetting, melting or casting.

The following documents are cited in the International Search Report:

D1: US 4 647 358 A  
D2: FI 88520 B  
D3: US 3 857 774 A

D1 reveals a method of fabricating a suspension bar for a cathode. The suspension bar is manufactured from steel pipe with a pipe of an electroconductive material placed inside. The internal diameter of the steel pipe is almost that of the outer diameter of the electroconductive pipe so that the pipes are in close contact with each other. The composite hollow body of steel and electroconductive material is deformed by an application of pressure in such a manner that the composite forms an elliptical shape.

.../...

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No.  
PCT/FI99/00782

**Supplemental Box**  
(To be used when the space in any of the preceding boxes is not sufficient)

Continuation of: V.

To join the two pipes i.e. by drawing in order to force the two pipes in close contact with each other is considered to only come within the scope of practice followed by a person skilled in the art.

Consequently, the method according to claim 1 is not considered to involve an inventive step.

Furthermore, claims 2-7 are considered to merely express routine measures, see e.g. D1 which discloses an inner electroconductive pipe of copper.

D2 and D3 are considered to only represent close background art.

None of the documents, taken alone or in combination, reveals the invention defined in claims 8-17. Furthermore, in the cited documents there are no suggestions leading a person skilled in the art towards the invention defined by claims 8-17.

In view of the arguments stated above, the claimed invention according to claims 1-7 is novel but is not considered to involve an inventive step. The claimed invention according to claims 8-17 is novel and is considered to involve an inventive step. The claimed invention according to claims 1-17 fulfil the criterion of industrial applicability.

# PATENT COOPERATION TREATY

Received

From the  
INTERNATIONAL PRELIMINARY EXAMINING AUTHORITY

**PCT**

To:

Outokumpu OYJ Intellectual  
Property Management  
P.O. Box 27  
FIN-02201 Espoo  
Finland

## NOTIFICATION OF TRANSMITTAL OF INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Rule 71.1)

Date of mailing  
(day/month/year)      **20-12-2000**

Applicant's or agent's file reference  
**982060 WO**

### IMPORTANT NOTIFICATION

International application No.  
**PCT/FI99/00782**

International filing date (day/month/year)  
**23-09-1999**

Priority date (day/month/year)  
**24-09-1998**

Applicant  
**Outokumpu Oyj  
et al**

1. The applicant is hereby notified that this International Preliminary Examining Authority transmits herewith the international preliminary examination report and its annexes, if any, established on the international application.
2. A copy of the report and its annexes, if any, is being transmitted to the International Bureau for communication to all the elected Offices.
3. Where required by any of the elected Offices, the International Bureau will prepare an English translation of the report (but not of any annexes) and will transmit such translation to those Offices.
4. **REMINDER**

The applicant must enter the national phase before each elected Office by performing certain acts (filing translations and paying national fees) within 30 months from the priority date (or later in some Offices) (Article 39(1)) (see also the reminder sent by the International Bureau with Form PCT/IB/301).

where a translation of the international application must be furnished to an elected Office, that translation must contain a translation of any annexes to the international preliminary examination report. It is the applicant's responsibility to prepare and furnish such translation directly to each elected Office concerned.

For further details on the applicable time limits and requirements of the elected Offices, see Volume II of the PCT Applicant's Guide.

Name and mailing address of the IPBA/  
Patent- och registreringsverket  
Box 5055  
S-102 42 STOCKHOLM  
Facsimile No.    08-667 72 88

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17978  
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Authorized officer

**Hediye GÜzel**

Telephone No.    08-782 25 00

# PATENT COOPERATION TREATY

## PCT

### INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference 982060 WO	<b>FOR FURTHER ACTION</b> See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416)	
International application No. PCT/FI99/00782	International filing date (day/month/year) 23.09.1999	Priority date (day/month/year) 24.09.1998
International Patent Classification (IPC) or national classification and IPC <sub>7</sub> C25C 7/02		
Applicant Outokumpu Oyj et al		

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- IV ☐ Lack of unity of invention
- V ☒ Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
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Date of submission of the demand  14.04.2000	Date of completion of this report  19.12.2000
Name and mailing address of the IPEA/SE Patent- och registreringsverket Box 5055 S-102 42 STOCKHOLM Facsimile No. 08-667 72 88	Authorized officer  Ulrika Nilsson/MP Telephone No. 08-782 25 00



**I. Basis of the report****1. With regard to the elements of the international application:\***☒ the international application as originally filed☐ the description:

pages \_\_\_\_\_, as originally filed

pages \_\_\_\_\_, filed with the demand

pages \_\_\_\_\_, filed with the letter of \_\_\_\_\_

☐ the claims:

pages \_\_\_\_\_, as originally filed

pages \_\_\_\_\_, as amended (together with any statement) under article 19

pages \_\_\_\_\_, filed with the demand

pages \_\_\_\_\_, filed with the letter of \_\_\_\_\_

☐ the drawings:

pages \_\_\_\_\_, as originally filed

pages \_\_\_\_\_, filed with the demand

pages \_\_\_\_\_, filed with the letter of \_\_\_\_\_

☐ the sequence listing part of the description:

pages \_\_\_\_\_, as originally filed

pages \_\_\_\_\_, filed with the demand

pages \_\_\_\_\_, filed with the letter of \_\_\_\_\_

**2. With regard to the language, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.**  
These elements were available or furnished to this Authority in the following language \_\_\_\_\_ which is:☐ the language of a translation furnished for the purposes of international search (under Rule 23.1(b)).☐ the language of publication of the international application (under Rule 48.3(b)).☐ the language of the translation furnished for the purposes of international preliminary examination (under Rules 55.2 and/or 55.3).**3. With regard to any nucleotide and/or amino acid sequence disclosed in the international application, the international preliminary examination was carried out on the basis of the sequence listing:**☐ contained in the international application in written form.☐ filed together with the international application in computer readable form.☐ furnished subsequently to this Authority in written form.☐ furnished subsequently to this Authority in computer readable form.☐ The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.☐ The statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished.**4. ☐ The amendments have resulted in the cancellation of:**☐ the description, pages \_\_\_\_\_☐ the claims, Nos. \_\_\_\_\_☐ the drawings, sheet/fig \_\_\_\_\_**5. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed, as indicated in the Supplemental Box (Rule 70.2 (c)).\*\***

\* Replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are annexed to this report since they do not contain amendments (Rules 70.16 and 70.17).

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# INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No.

PCT/FI99/00782

## V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

### 1. Statement

Novelty (N)	Claims	<u>1-17</u>	YES
	Claims		NO
Inventive step (IS)	Claims	<u>8-17</u>	YES
	Claims	<u>1-7</u>	NO
Industrial applicability (IA)	Claims	<u>1-17</u>	YES
	Claims		NO

### 2. Citations and explanations (Rule 70.7)

The claimed invention relates to a method for manufacturing a suspension bar, consisting of a rigid metal outer jacket enclosing a highly electroconductive inner part, for a permanent cathode used in the electrolysis of metals. The aim of the claimed invention is to enable a tight contact between the outer refined steel jacket and the highly electroconductive core. For this purpose, the outer jacket of refined steel and the core are joined together by drawing, upsetting, melting or casting.

The following documents are cited in the International Search Report:

D1: US 4 647 358 A  
D2: FI 88520 B  
D3: US 3 857 774 A

D1 reveals a method of fabricating a suspension bar for a cathode. The suspension bar is manufactured from steel pipe with a pipe of an electroconductive material placed inside. The internal diameter of the steel pipe is almost that of the outer diameter of the electroconductive pipe so that the pipes are in close contact with each other. The composite hollow body of steel and electroconductive material is deformed by an application of pressure in such a manner that the composite forms an elliptical shape.

.../...

**Supplemental Box**

(To be used when the space in any of the preceding boxes is not sufficient)

Continuation of: V.

To join the two pipes i.e. by drawing in order to force the two pipes in close contact with each other is considered to only come within the scope of practice followed by a person skilled in the art.

Consequently, the method according to claim 1 is not considered to involve an inventive step.

Furthermore, claims 2-7 are considered to merely express routine measures, see e.g. D1 which discloses an inner electroconductive pipe of copper.

D2 and D3 are considered to only represent close background art.

None of the documents, taken alone or in combination, reveals the invention defined in claims 8-17. Furthermore, in the cited documents there are no suggestions leading a person skilled in the art towards the invention defined by claims 8-17.

In view of the arguments stated above, the claimed invention according to claims 1-7 is novel but is not considered to involve an inventive step. The claimed invention according to claims 8-17 is novel and is considered to involve an inventive step. The claimed invention according to claims 1-17 fulfil the criterion of industrial applicability.

**PCT**WORLD INTELLECTUAL PROPERTY ORGANIZATION  
International Bureau

## INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

<b>(51) International Patent Classification <sup>7</sup> :</b> <b>C25C 7/02</b>	<b>A1</b>	<b>(11) International Publication Number:</b> <b>WO 00/17419</b> <b>(43) International Publication Date:</b> 30 March 2000 (30.03.00)
<b>(21) International Application Number:</b> PCT/FI99/00782 <b>(22) International Filing Date:</b> 23 September 1999 (23.09.99) <b>(30) Priority Data:</b> 982060 24 September 1998 (24.09.98) FI <b>(71) Applicant (for all designated States except US):</b> OUTOKUMPU OYJ [FI/FI]; Riihitontuntie 7, FIN-02200 Espoo (FI). <b>(72) Inventor; and</b> <b>(75) Inventor/Applicant (for US only):</b> MARTTILA, Tom [FI/FI]; Humaljärventie 5, FIN-02400 Kirkkonummi (FI). <b>(74) Agent:</b> OUTOKUMPU OYJ; Patent Services, P.O. Box 27, FIN-02201 Espoo (FI).		<b>(81) Designated States:</b> AU, BG, BR, CA, CN, IN, JP, KR, MX, PL, US, ZA, Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE).  <b>Published</b> <i>With international search report.</i> <i>Before the expiration of the time limit for amending the claims and to be republished in the event of the receipt of amendments.</i>
<b>(54) Title:</b> METHOD FOR MANUFACTURING OF A CATHODE SUSPENSION BAR  <b>(57) Abstract</b>  The present invention relates to a method for manufacturing a suspension bar for a permanent cathode used in the electrolysis of metals, wherein the suspension bar is formed of a rigid metal outer jacket and a highly conductive core attached inside it. By means of this connection, a tight contact is achieved between the outer jacket and the core and this connection is made by drawing, upsetting, melting or casting.		

**FOR THE PURPOSES OF INFORMATION ONLY**

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

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CU	Cuba	LC	Saint Lucia	RU	Russian Federation		
CZ	Czech Republic	LI	Liechtenstein	SD	Sudan		
DE	Germany	LK	Sri Lanka	SE	Sweden		
DK	Denmark	LR	Liberia	SG	Singapore		
EE	Estonia						

## METHOD FOR MANUFACTURING OF A CATHODE SUSPENSION BAR

The present invention relates to a method for manufacturing a suspension bar for a permanent cathode used in the electrolysis of metals, wherein the suspension bar is formed of a rigid metal outer jacket and a highly conductive core attached inside it. By this method, a good connection is achieved between the outer jacket and the core. This connection is made by drawing, upsetting, melting or casting.

- 10 In the electrolysis of metals, a traditional method involves the use of starting sheets which are first grown on the surfaces of mother plates. Using this kind of starting sheets then as cathodes which are of the same metal as the metal to be precipitated, eg copper, is being phased out especially when new investments are concerned. When building new electrolysis tank
- 15 houses, the trend has been towards the use of permanent cathodes and the sheet-like part of the cathode is generally is made from acid-resistant steel or titanium.

- Permanent cathodes have been manufactured in many different ways, the principal difference being in the structure of the cathode suspension bar and the fastening of the plate part to the suspension bar. The structure of the suspension bar and attaching the plate part are problematic in that in order to conduct a large electric current to the plate part, there has to be enough copper in the suspension bar. Since acid-resistant steel is a poor conductor,
- 20 it cannot be the sole material used in the bar.
- 25

- There are several methods in the prior art to solve the combination of copper and another metal in the manufacture of the suspension bar of permanent cathodes. The commercial market is dominated by two forms of construction. The first of these uses an all-copper suspension bar, to which an acid-resistant steel plate part is welded using a specially alloyed welding
- 30

wire. One drawback of this method is the softness of a suspension bar made wholly of copper, as a consequence of which the bar is easily deformed, especially if larger cathode weights are used. A temperature increase caused by short circuits further exacerbates this problem.

5

A second disadvantage of the all-copper suspension bar is that it is difficult to attach separate lifting lugs firmly enough to the suspension bar, which lifting lugs will be on the top of the suspension bar as required by state-of-the-art material handling. The third disadvantage is that the special alloy welding required for attaching the acid-resistant steel plate part and the copper suspension bar is not at all as corrosion-resistant as the other parts of the cathode. The advantages of this construction are that making this kind of permanent cathode is quick, requires low investments and there are no special demands as to the location of the fabrication process.

10

15 Another advantage is the large cross-sectional area of copper in the suspension bar, which leads to low resistance and consequently low power losses in the actual structure of the permanent cathode.

In the second, widely used construction of a permanent cathode suspension bar, a tubular suspension bar core is made of stainless or acid-resistant steel. An acid-resistant plate part is welded with welding wire conventional to these materials. After being attached, the suspension bar and the uppermost part of the plate part, where the welds are located, are plated electrolytically with copper in order to achieve adequate electroconductivity.

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25 Copper plating also protects the welds from environmental impact. This method is described for example in GB patent 2,040,311.

The most notable disadvantage of the method described above is that the electrolytic plating requires a long time, several days, as a result of which production throughput time increases considerably and the electroplating demands large investments in equipment. Because of the electroplating,

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the fabrication line must be in the immediate vicinity of an operational electrolysis tankhouse. In this construction, the cross-sectional surface of the copper is smaller than for example in the previously described construction, where the suspension bar is all copper. This in turn leads to  
5 the presently described permanent cathode having a slightly higher resistance in its own construction and the ensuing energy losses are greater than when an all-copper suspension bar is used. On the other hand, a steel-core suspension bar does have great durability whereby the permanent cathode will keep its shape well even with great cathode weights,  
10 nor do short-circuits cause problems to the life time of the cathode. It is also much easier to attach the above-mentioned separate lifting lugs to this kind of construction. The lifting lugs are welded secure to the steel core of the bar before electrolytic copper plating, which makes the construction strong and durable. In this design, all welds occur between the steel parts and  
15 remain under the copper plating, thereby making the connections strong and longlasting.

US patent 4,647,358 describes a further permanent cathode, where the outermost part of the suspension bar is manufactured from steel pipe,  
20 attached to the plate part by welding. A hollow copper pipe is placed inside the suspension bar steel pipe, which is either longer than the steel pipe or the steel pipe is at least partially open at the ends so that the current flow occurs via the copper inner pipe of the suspension bar. The internal diameter of the steel pipe is almost that of the outer diameter of the copper  
25 pipe so that the pipes are in close contact with each other. The outer jacket, of which the manufacturing method is described in the patent, is initially open longitudinally so that the inner tube is easier to position and after installing the inner pipe the outer jacket is attached to the pipe longitudinally by welding. Both the inner pipe and outer jacket at the ends of the bar are  
30 welded to each other.



Advantages of the previously described method are the great strength of the bar and also that both the cathode plate part and the separate lifting lugs can be welded directly to the jacket section which is of the same metal. The disadvantage however, is that, in order to achieve proper contact, separate welds and/or blanking between the jacket and the core are required. As a result, in large production quantities it is difficult to get bars of uniform quality. Another disadvantage is that the jacket and the core have to be welded together at the ends so that the construction will be tight and not exposed to corrosion, since any electrolyte getting between the jacket and the core is not good for the long-term durability of the bar. Production therefore requires numerous working steps that are difficult to automate, so that the high costs of production become a problem and as already mentioned, the assurance of uniform quality may be overwhelming.

This invention focuses on a method to manufacture a permanent cathode suspension bar used in the electrolysis of metals, whereby the suspension bar is fabricated from a rigid metal outer jacket inside which a highly electroconductive core is placed either by drawing, upsetting, melting or casting. The aim of these techniques is to achieve a sufficiently good electrical contact and tightness between the jacket and the core without any additional working steps. The most preferable is to achieve a metallurgical bond between the parts of the bar. Thus, it is enough, after joining the jacket and the core, that the jacket is machined partially open at one end at least to generate a good electrical contact between the cathode suspension bar and the tank busbar. The essential features of the invention will become apparent in the attached patent claims.

The text mainly refers to copper as the highly electroconductive core metal, but it can also be aluminium. The rigid metal outer jacket is preferably manufactured from refined steel so that it may be acid-resistant or stainless steel.

When the suspension bar is formed by drawing, a highly electroconductive core is made for the bar by drawing copper through the inside of the ready outer jacket. When the outer jacket is for example made of refined steel, the easiest way is to do it beforehand, as refined steel is difficult to draw. This will preferably happen so that a tubular preform suitable for the inside of the steel jacket is made of copper. This preform is put inside the steel jacket and an arbor is drawn through the hole in the copper preform in the drawing machine, which forces the copper tightly against the surface of the steel jacket. A steel bar can also be used as an arbor either drawn or pushed into the hole in the copper preform and if required can also be left inside the finished bar. During production, the steel jacket can, if necessary, be supported from outside in order to prevent deforming. The shaping of the copper and its binding to the steel can be affected by adjusting the temperature.

A permanent cathode suspension bar can also be fabricated by upsetting, whereby a suitable core is set inside the outer jacket so that by pressing the ends of the core it may be extruded very tight to the jacket at least at the important places i.e. at the ends. The temperature can be adjusted to favour the shaping of the copper as in drawing. Depending on the temperature used, a metallurgical contact between the jacket and the core can be made also by drawing or upsetting.

Fabricating of the suspension bar by melting is done so that a copper core preform which is beforehand made by, for example, casting, drawing or machining, is first put in solid form inside the steel jacket and then melted there by heating the jacket and the core preform. Melting can be done in a vertical position when it is preferential to plug the lower end of the steel tube. Then the tube both supports the core preform and retains the molten copper inside the jacket tube. During the heat treatment, the jacket remains

in sufficiently solid form. The bond between steel and copper can be adjusted with the temperature and with the time the copper is kept in molten condition, and by using a suitable combination a metallurgical bond is achieved.

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When the suspension bar is fabricated by casting, it is done so that the outer jacket of steel tube acts as a mould inside which the copper core is cast directly. However, the jacket remains in sufficiently solid form. Any potential adhering of the copper to the outer surface of the steel jacket can be prevented by, for example, graphite solution treatment or some other coating. By casting molten copper inside the solid steel jacket, a reliable metallurgical bond between the steel and the copper can be formed.

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The casting itself occurs e.g. by pouring molten core metal inside an upright steel tube, which is closed at the lower end. It is preferable to preheat the steel jacket powerfully or to additionally heat the whole bar (jacket + core) after pouring the melt. It is essential that the jacket is enough long time in actual contact with the molten copper so that a metallurgical bond has time to form between the jacket and the core. If the jacket tube is not heated in advance, or the whole bar during or after casting, there will be no cracking, but the core metal will solidify so quickly on the cold inner wall of the jacket that no bond will be form.

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Another method of filling the steel jacket is to immerse it in copper melt for enough long time when preheating is maybe not necessary at all. Immersion can be made with the tube in a horizontal position, in which case before immersing the steel jacket both ends are plugged and a sufficient number of holes are made in the upper side of the tube for the feed of the copper and the release of air. A suitable amount is for example one hole at either end of the tube. The tube may also be held in an inclined position to ensure the melt fills the inside. Immersion may also of course be made in a vertical

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position, wherein only the lower end of the steel jacket is plugged before immersion. For example, immersion for approximately one minute is sufficient to obtain a good end result.

- 5 As previously found, a contact of good electroconductive metals is desired between the permanent cathode and the electrolytic tank busbar, so that the current flows between them with little loss. This is easy to achieve with a drawn, upset, smelted or cast core so that, for example, after connecting the parts of the bar, the steel jacket can be removed from one side of the bar, at  
10 either both ends or only one end, at a suitable length from the face of the copper core. At the same time, the cross-sections of the copper contact of the bar can be formed to the required shape, for instance, cambered.

- Separate lifting lugs made of refined steel are welded as required directly to  
15 the steel jacket of the suspension bar. Likewise, the cathode plate part is welded directly to the steel jacket. The plate part and lifting lugs can be attached to the suspension bar steel jacket either before the copper core is attached or afterwards and the welds are always made joining pieces of the same material so they are easy to do and durable.

## PATENT CLAIMS

1. A method for manufacturing a suspension bar for a permanent cathode used in an electrolysis of metals, wherein the suspension bar is made of a rigid metal outer jacket and a highly electroconductive inner part inside it, after which the outer jacket is removed at least from one end of the bar, **characterized in that** a refined steel outer jacket and a highly electroconductive core are in close contact with each other, wherein the parts of the bar are joined to each other by drawing, upsetting, melting or casting.
2. A method according to claim 1, **characterized in that** the highly electroconductive core is copper.
3. A method according to claim 1, **characterized in that** the highly electroconductive material is aluminium.
4. A method according to claim 1, **characterized in that** the core is connected to the outer jacket by placing a core preform inside the outer jacket and by drawing an arbor through the preform in a drawing machine.
5. A method according to claim 4, **characterized in that** a steel bar is used as the arbor.
6. A method according to claim 5, **characterized in that** the steel bar is left inside the highly electroconductive core.
7. A method according to claim 1, **characterized in that** the core is connected to the outer jacket by placing a core preform inside the outer jacket and by pressing the ends of the core, so that the core is extruded tight to the jacket.

8. A method according to claim 1, **characterized in that** in order to obtain a metallurgical bond between the jacket and the core, the core is attached to the jacket by casting it in molten form inside the solid jacket.

5 9. A method according to claim 8, **characterized in that** casting is made using the outer jacket as the mould into which the molten core metal is poured.

10 10. A method according to claim 1, **characterized in that** in order to obtain a metallurgical bond between the jacket and the core, the core preform is placed in solid form inside the outer jacket and then the core is melted inside the outer jacket which remains in sufficiently solid form.

15 11. A method according to claim 8 or 10, **characterized in that** the outer jacket is preheated before bonding.

12. A method according to claim 8 or 10, **characterized in that** the outer jacket and the core are heated during bonding.

20 13. A method according to claim 8 or 10, **characterized in that** the outer jacket and the core are heated after bonding.

25 14. A method according to claim 8 or 10, **characterized in that** the outer jacket is held in a vertical position with the bottom end closed when core metal is put into the jacket.

15. A method according to claim 8, **characterized in that** casting is made by immersing the outer jacket into a melt of core metal.

16. A method according to claim 15, **characterized in that** the outer jacket is immersed in the melt essentially in a horizontal position, wherein the ends of the jacket are closed and that holes are made in the upper part of the jacket for pouring the melt and releasing air.

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17. A method according to claim 15, **characterized in that** the outer jacket is immersed in the melt essentially in a vertical position, wherein the bottom end of the jacket is closed.

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# INTERNATIONAL SEARCH REPORT

International application No.  
PCT/FI 99/00782

## A. CLASSIFICATION OF SUBJECT MATTER

**IPC7: C25C 7/02**

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

**IPC7: C25C**

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

**SE,DK,FI,NO classes as above**

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

**WPI, EPODOC**

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 4647358 A (ADALBERT BARTSCH ET AL), 3 March 1987 (03.03.87)  --	1-3,7
Y	FI 88520 B (OUTOKUMPU PORICOPPER OY), 15 February 1993 (15.02.93), claims 1-3  --	4-6
A	US 3857774 A (PETER HARLOW MORTON ET AL), 31 December 1974 (31.12.74)  -- -----	1

☐ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

\* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention.

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"Y" document of particular relevance: the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search

**19 January 2000**

Date of mailing of the international search report

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# INTERNATIONAL SEARCH REPORT

Information on patent family members

02/12/99

International application No.

PCT/FI 99/00782

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